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NPRDC TR 84-24 February 1984

PRODUCTIVITY ENHANCEMENT PROGRAM (PEP) FOR THE POWER PLANT DIVISION, NAVAL AIR REWORK FACILITY, NORTH ISLAND, SAN DIEGO: PRELIMINARY DATA REQUIRED

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report provides preliminary information needed for the development of a productivity enhancement program (PEP) at PPD, NARF North Island.

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S/N 0102-LF-014-6601

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FOREWORD

This effort was conducted as the initial phase of a develpment project to implement a productivity enhancement program (PEP) at the Power Plant Division (PPD), Naval Air Rework Facility, North Island, San Diego, California. The objectives of this phase were to describe the current organization and shop operations within the PPD. The results provide a basis and a perspective by which project personnel can develop an individualized PEP for the PPD.

This work is part of a continuous program to improve civilian work force productivity. Similar programs have resulted in increased productivity of key punch operators and supply workers. Because of the varying nature of the work in various areas, a PEP must be tailored for each area.

Appreciation is expressed for the high level of support and coordination received from the management and work force of the PPD, especially the following:

- Mr. Pegas and Mr. Lee, PPD Directors, for their full support during the time of data collection.

- Mr. Cohee and Mr. Charvat, General Foremen, for their day-to-day support during the entire data collection period.

- Support group personnel, for their willing assistance whenever requested.

J. W. RENARD
Captain, U.S. Navy
Commanding Officer

J. W. TWEEDDALE
Technical Director

SUMMARY

Problem

The Navy Personnel Research and Development Center has developed productivity enhancement programs (PEPs) for key punch operators and purchasing clerks within selected naval shipyards and is developing PEPs for other naval activities. Before a PEP can be developed for an organization, it is necessary to obtain information concerning its structure, operations, and workflow and any impediments to that workflow. The current plan is to develop a PEP for the Power Plant Division (PPD), Naval Air Rework Facility (NARF), North Island, San Diego.

Objective

The objective of this effort was to obtain the necessary information needed before a PEP can be developed for the PPD.

Approach

Eight shops were selected to participate in the effort. For these shops, data were collected as follows:

1. PPD management and workers were interviewed to obtain general organizational information and to identify impediments.

2. Workflow charts were prepared for representative engine units that are processed through the eight selected PPD shops.

3. The controlling and accounting materials used within the shops were reviewed.

4. Foremen were asked to complete a mini-survey indicating the degree to which their shops met various criteria.

Results were analyzed to determine which shops should serve as experimental shops in the forthcoming PEP and which should serve as control shops.

Results

The selected shops reasonably meet the criteria for successfully developing a PEP; that is, worker productivity was sufficiently under his/her own control and the workload was sufficient to warrant an increase in productivity. Fourteen impediments were identified that either do or could cause workflow problems, but should be manageable or eliminated during PEP development.

Conclusions

It appears that PPD's structure, operations, management, and workflow make it a sound candidate for a PEP. The management and the workforce have demonstrated an active willingness to participate in the development effort. The PPD repair operations are complex and extensive but are organized and conducive to performance measurement, which is one of the keys to developing a successful PEP.

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INTRODUCTION

Problem and Background

The Navy Personnel Research and Development Center has developed productivity enhancement programs (PEPs) for key punch operators and purchasing clerks within selected naval shipyards and is currently developing PEPs for other naval activities. The current plan is to develop a PEP for artisans working in the Power Plant Division (PPD), Naval Air Rework Facility (NARF), North Island, San Diego. Before a PEP can be developed, however, information is needed on the structure and operations of the organization, the workflow, and any impediments to that workflow. This information is used to determine whether (1) the workload is large enough to withstand an increase in productivity without running out of work, (2) there is some reasonably reliable and valid means of measuring workers' productivity, (3) management--from shop foremen to top levels--will support the program, and (4) any punitive actions (e.g., negative incentives) could result from the program.

NARF North Island is one of six NARFs in the United States. Although each NARF processes a different variety of aircraft, their general purpose is to dismantle, inspect, and repair aircraft that have come from the fleet after a tour of duty for scheduled maintenance or because major problems have developed. The PPD at NARF North Island is responsible for the rework/overhaul of jet engines, which is a highly involved process. At any given time, the PPD is processing from 15 to 20 jet engines, each of which has between two and eight thousand parts. PPD is responsible for tracking these parts, as well as performing machining, coating, welding, and other rework operations.

Purpose

The purpose of this effort was to obtain the necessary information needed before a PEP can be developed for the PPD.

APPROACH

PPD Organization

The PPD is organized in the traditional hierarchical structure. As shown in Figure 1, the PPD has two branches, each branch has two sections, and each section has approximately five shops. It should be noted that Figure 1 reflects a recent reorganization that changed the organization from being "process"-oriented to one based primarily on "products" (i.e., engines and their components). This means that each shop is responsible for all or most of the rework considered necessary to produce the product that is reflected in its title. For example, shop number 96314 is responsible for T64 small engine rework and test. The actual tasks performed by the artisans have not changed but some artisans now work under different foremen, have different position descriptions (PDs), and/or have been moved to different locations. For example, a new PD for "pneudraulics" mechanics was introduced to classify mechanics who work on components associated with fluid and air controls.

Selection of Shops

At first, through discussions with PPD management, seven shops under Code 96400 (Engine Accessories and Processing Branch) were selected for inclusion in this

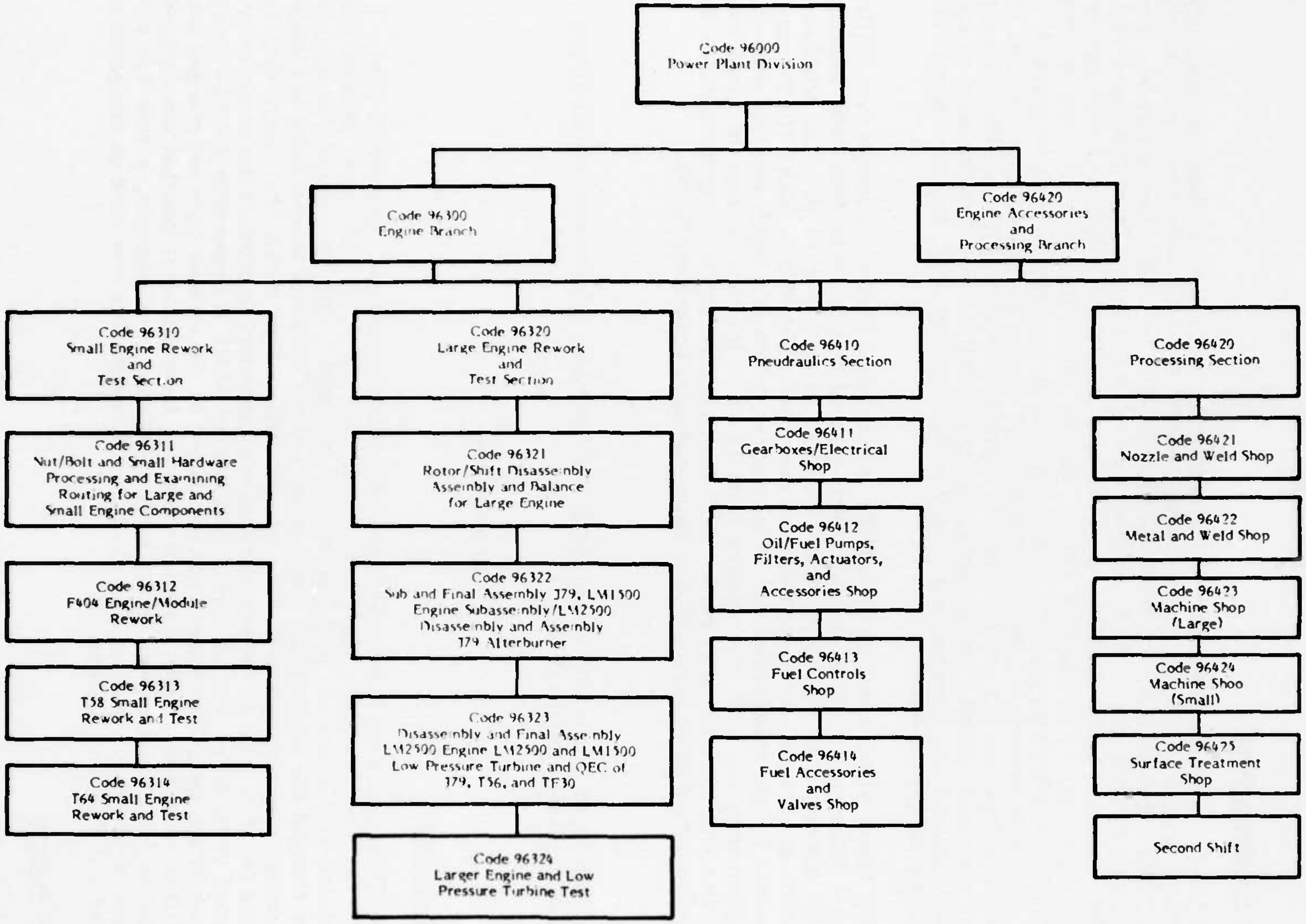

Figure 1. Power Plant Division organization.

effort--Nos. 96411, 96412, 96413, 96414, 96421, 96422, and 96424. Later, one shop under Code 96300 (Engine Branch)--No. 96314--was added. It was considered that one shop was sufficient since the primary distinction among Code 96300 shops is product line (types of engines). The shop processes are similar; namely, disassemble, inspect, assemble, test, and sell an engine.

Data Collection

Data were collected as follows:

1. PPD management and workers were interviewed to obtain general organizational information and to identify impediments.

2. Workflow charts were prepared for representative engine units that are processed through the eight selected PPD shops.

3. The controlling and accounting materials used within the shops were reviewed.

4. Foremen were asked to complete a mini-survey indicating the degree to which their shops met the following criteria:

   a. Work is measured objectively (covered by standards).
   b. Work could be measured objectively.
   c. Valid performance standards are in place.
   d. Performance is tied directly to a specific individual.
   e. Work is recurring in nature.
   f. Work pace is controlled by the individual.

Analysis

Results were analyzed to determine which shops should serve as experimental shops in the forthcoming PEP and which should serve as control shops. The objective was to have the experimental and control shops as similar to one another as possible in terms of:

1. Percentage of criteria (see above) met by each shop.
2. Percentage of the workload covered by the workflow charts.
3. The number of people in the respective shops.
4. The ratio of flow process steps to transactions.

In regard to 4 above, it should be noted that there were no restrictions on what a foreman wished to call a "step" in describing a process. However, responses do provide a rough indicator for the shop comparisons.

RESULTS

PPD Function and Workload

When an engine arrives at PPD for rework, it is examined and all maintenance reports and schedules, relevant engineering change orders, and other related documents are reviewed to determine which engine components will be reworked and which will be sent

to a holding pool. Based upon results of the examination, component parts can follow one of three different routes:

1. Parts that do not need reworking are sent to a holding pool for that component.

2. Parts that do need reworking are sent to the appropriate shops for machining, coating, or any other number of possible operations.

3. Parts that are beyond repair are scrapped and replacement part ordered.

In summary, a jet engine that goes into the PPD is disassembled, reworked, reassembled, tested, and returned for another tour of fleet duty. The PPD reworks six different jet engines and an assortment of other aircraft parts (e.g., refueling nozzles). Four of the six engines--J-79, T-58, T-64 and F-404--are aircraft engines, while the other two--LM 1500 and LM 2500--are used in Navy surface ships. Each aircraft engine has several modified versions that requires variations in the rework processes. Also, since the F-404 is a new addition to the PPD's workload and has recently been subjected to a pilot program, there will be frequent adjustments to the rework processes until sufficient experience is gained in reworking the F-404. Finally, other nonengine aircraft parts regularly come in for rework from the NARF rework hangars. In some shops, reworking these parts represents a substantial part of the workload.

Labor Force

The PPD labor force comprises 369 artisans, trained in the following skills required to rework jet engines:

1. Sandblaster.
2. Electroplate worker (cleaner).
3. Buffer and polisher.
4. Welder.
5. Shop peener.
6. Heat treater.
7. Preservation packaging mechanic.
8. Aircraft engine mechanic.
9. Aircraft metalsmith.
10. Machinist.
11. Painter.
12. Aircraft electrician.
13. Aircraft engine metal worker.
14. Pneudraulic mechanic.

Skill levels within the labor force range between Wage Grades 8 and 10, with lesser wage grades for apprentices and trainees. The work force is predominantly male and ranges in age between 18 and 66 years, with an average of 41. Overall, members of the work force gave no indication of having any unusual attitudes toward any group or management.

Support Groups

Six primary support groups directly influence PPD's workflow, although they are not directly controlled by PPD management. These groups are listed below; their roles and functions in regard to PPD workflow are described in the following paragraphs.

1. Planning and Estimating (P&E).
2. Operational Analysis (OA).
3. Methods and Standards (M&S).
4. Production Control (PC).
5. Examinators and Evaluators (E&E).
6. Engineering.
7. Quality Assurance (QA).

Planning and Estimating (P&E)

The P&E group is responsible for developing the internal workload plans and schedules, based upon the number and types of engines scheduled for each quarter. Although PPD's engine program manager negotiates with the Naval Logistic Supply Center as to the number and kinds of engines that will be reworked by the PPD annually, the actual working time frame is quarterly. The engines come from two main sources: (1) the NARF rework hangars, where entire airplanes are reworked, and (2) the supply system itself ("trade-ins" from the fleet). Using the schedule of planned engine arrivals, the P&E group schedules the engines and determines when, during the quarter, the engine will be inducted, based on such factors as material and equipment availability, required overtime if any, etc.

The planners use the master data record (MDR), which is prepared by the OA Group (see below) for each type, model, and series (TMS) of engine, to determine the actual direction of the work flow through the shops. They also consider the process times required by the various shops, as well as the within and between shop transport times.

Numerous circumstances make scheduling (and/or rescheduling) a continuous activity. Engines do not always arrive at the PPD as scheduled; in some cases, they do not arrive at all. There are many reasons for this: An aircraft's deployment schedule can be changed, funds for rework on a given TMS engine may be withdrawn, or ordered parts may not be available. Since any given jet engine includes between 2000 to 8000 parts, it is not surprising that there are availability problems. Although the amount of supplies stored are determined based on how frequently a part is replaced, this practice has its shortcomings. For example, when an engine part with a long wear cycle must finally be replaced, none is available and the workflow schedules can be disrupted.

Operation Analysis (OA)

This group establishes and maintains the MDR, which, as mentioned earlier, is used to route an engine through the various shops. The MDR lists all required processes for a complete rework of an engine, including identification of all parts, processes, and shops needed to perform the work. The 12-digit component identity number (CIN) (see upper left-hand corner of Figure 2), identifies all sections, assemblies, subassemblies, and sub-subassemblies of the engine. Figure 3 presents the MDR CIN structure in terms of three groups of numbers. The first digit of the first group represents the section of the engine being worked on; and the last three digits, the assembly. The middle group of four digits is not used. In the last group, the first digit represents the subassembly; and the remaining three, sub-subassemblies and their parts. The MDRs for a "new engine" pilot program are established before the first engine arrives at the NARF for rework, based on engineering documents provided by the manufacturer and government directives.

MASTER DATA RECORD AUG 27 1981

PREVIOUS ISSUES OF THIS FORM ARE OBSOLETE

CONTROL GROUP		PART IDENTIFICATION GROUP							
MDR CONTROL CODE	COMPONENT IDENTITY NO	MDR LOC	S C	INDUCTED FEDERAL STOCK NUMBER	MODIFIED FEDERAL STOCK NUMBER	MODEL CODE	QUANTITY	PROCUREMENT COST	REVISION DATE MO DAY YEAR
2YCCO	1C04DUCCCUCG	1C1				F4C4	NC01	Y	07-23-81

STATUS CODE	ERROR CODE	MDR LOCATION	MANUFACTURER'S PART NUMBER	R D I	W A C	PRODUCT STD	CLASS STD	WORKLOAD STD	DISP CODE	MEA CODE	ANALYST CODE OA	MAS
Q		1C2	6C461C0G01	1	3				BW	5	01Y	100

	MDR LOCATION	PUBLICATION NUMBER	PART NAME	RELATED DESCRIPTION	B CODE
300133	1C3	A1-F434A-MMO-300:C95	OIL TANK A	Y1DG-Y1UO	

LOAD AND SCHEDULE GROUP

MDR LOC	SHOP NUMBER	GEO AREA	SHOP CAT CODE	OPERATION CODE	OPERATION STANDARD		OCCURRENCE FACTORS SURV		PROD	HAND TIME	NORMAL FLOW TIME	STA FACT	END FAC	COMP HOUR	SH LMT	WEIGHTED OPERATION STANDARD	TRADE CODE	MDR LOCATION	OPERATION DESCRIPTION	FACIL CODE	FACILITY STANDARD (HOURS)	OPER STD (DATE)
201	96422	G	6W	AAAA						00	004	00	04					301				
202	96324	G	MY							24	000	02	02	16				302	OIL TANK ASSEMBLY			
203			63															303	A1-F404A-MMI-210:070			
2044	96422	G	44	AAC1	.01	C				02	001	03	03	11		.01	999	304	52 DISAAEMBLY			11-0
2054	96411	G	EP	AAC2	.01	C				00	001	03	03	12		.01	999	305	51 CLEAN (MIL-C-7024)			11-0
2064	96422	G	44	AAC3	.01	C				00	001	03	03	13		.01	999	306	52 EXAM/REPAIR/ROUTE			11-0
207	56147	G	CX	Y1DG						00	010	03	04	15				307	52 OIL-TANK-ASSEMBLY			
2064	96422	G	44	AAC4	.01	C				02	001	05	05	10		.01	999	308	52 ASSEMBLE			11-0
209	56132	Q	XF							02	000	05	05	12				309	74 F.P.S.R. F404 AGB			

MISCELLANEOUS INFORMATION GROUP

MDR LOCATION	SPECIAL INSTRUCTIONS

TECHNICAL DATA GROUP

MDR LOCATION	TECHNICAL DIRECTIVES	MDR LOCATION	TECHNICAL DIRECTIVES	MDR LOCATION	TECHNICAL DIRECTIVES	MDR LOCATION	TECHNICAL DIRECTIVES

Figure 2. Master data record (MDR).

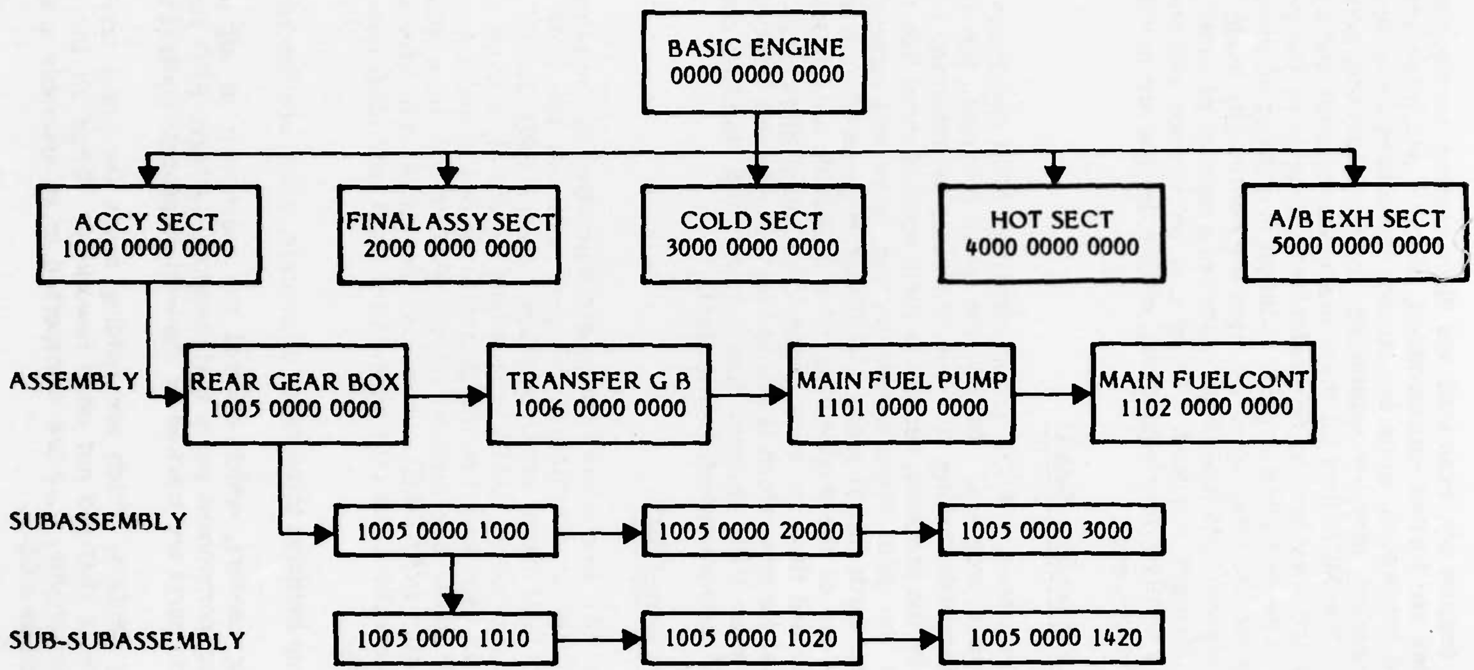

Figure 3. MDR CIN structure assembly chaining.

After the engines are examined and disassembled, sections are routed to the various shops where they are further disassembled, cleaned, and inspected for wear. Some parts are then routed for rework, some are stored, and others discarded and replaced. When all the parts are readied, they are assembled, tested, inspected, accepted, and returned for final assembly. The MDR lists all these processes, by code and a brief descriptive title in the order in which they are to be performed, along with the performing shop and the standard time. One component (part) could go in and out of the same shop several times before it leaves for the final time. Changes are continually made to the MDRs even after the engines of a given TMS have been reworked a number of times. The example in Figure 4 shows some changes required. There can be various reasons for the changes; for example, a shop receives new equipment, engine designs are modified, an artisan suggests improved procedures, etc.

Methods and Standards (M&S)

As indicated above, the OA group identifies MDR processes prior to the start of a "new engine" pilot program. During the pilot program, the pilot team verifies the methods and standards making up those processes by observing artisans performing each task called for by the proceses, recording their performances (see Figure 5), and analyzing results. When the pilot team agrees on the tasks and subsequent task motions, the Methods and Standards (M&S) group establishes engineered standard times for each task by referring to one of the engineering time standards data bases. The net result is an engineering standard time for each process, including allowances for personnel, fatigue, and supplemental factors, which is printed on that engine's MDR cards. The M&S group is also consulted when MDR changes also require time standard changes (e.g., when new, more automated shop equipment is installed).

Production Control (PC)

The PC and E&E (see below) groups are supervised by the same branch head, although they perform different functions. PC personnel use the MDR as a "map" to route components and their parts within and between the PPD shops. They also use uniform automated data processing (UADP) cards (see Figure 6), a more convenient form of the MDR that can be used with the transactor to record actual time used by an artisan per process. UADP cards are ordered by the P&E group from the Navy Regional Data Automation Center (NARDAC), which provides MDR computer services to the NARF. The PC group sorts the cards into packets for each individual component and gives them to the E&E group.

The PC group includes three types of centers, which are described below:

1. Routing centers, which control the movement of all incoming and outgoing engines, including component parts that temporarily leave PPD for rework elsewhere at the NARF. These parts are tracked by the work in process control system (WIPCS).

2. Kitting centers, which are holding areas for parts arriving from the rework processes and parts that did not need reworking. When all the components and parts arrive for a given engine, they are transported to an assembly area. A kitting center is usually supervised by a GS-7.

MASTER DATA RECORD

PREVIOUS ISSUES OF THIS FORM ARE OBSOLETE

CONTROL GROUP		PART IDENTIFICATION GROUP							
MDR CONTROL CODE	COMPONENT IDENTITY NO	MDR LOC	S C	INDUCTED FEDERAL STOCK NUMBER	MODIFIED FEDERAL STOCK NUMBER	MODEL CODE	QUANTITY	PROCUREMENT COST	REVISION DATE MO DAY YEAR
22E7C	310102000600	101					N001	Y	06-09-81

SOURCE CODE	ERROR CODE	MDR LOCATION	MANUFACTURER'S PART NUMBER	R O I	W A C	PRODUCT STD	CLASS STD	WORKLOAD STD	DAYS AVAIL	SKD LMT	DISP CODE	NEO CODE	ROT SPRS	WORK AREA	ANALYST CODE	
A		102	1745-654010 / 5770796P10	1	3				9			5		D	015	400

	MDR LOCATION	PUBLICATION NUMBER	PART NAME	RELATED DESCRIPTION	# CODE
00076	103	NAVAIR 03-1105A-11	MAIN F NOZ		

LOAD AND SCHEDULE GROUP

MDR LOC	SHOP NUMBER	GEO AREA	SHOP CAT CODE	OPERATION CODE	OPERATION STANDARD	STD	OCCURRENCE FACTORS SURV	INDUCT	PROD	HAND TIME	NORMAL FLOW TIME	STA FACT	END FACT	COMP HOUR	SHF LMT	WEIGHTED OPERATION STANDARD	TRADE CODE	MDR LOCATION	OPERATION DESCRIPTION	FACIL CODE	FACILITY STANDARD (HOURS)	OPER STD (DATE)
201	96415	4	MX							24	007	02	02	16				301	MAIN FUEL NOZZLE			
2024	96415	4	44	MPAC	.63	D				02	003	03	03	13		.63	999	302	59 REMOVE REGULATOR			06-1
2034	96411	4	2P	MDJI	.45	D				02	001	03	03	16		.45	999	303	1XA-1VK-1SJ/1TN-1SC/1SL-7F			10-9
2044	96415	4	44	MPAD	.41	L				02	001	04	04	11		.41	999	304	59 EXAM/ROUTE/REPAIR			05-9
2052	96415	4	65	T010														305	C/R ER 0176A			
2062	96415	4	65	T020														306	C/R PPC 0064			
207	96415	4	73															307	REF 401			
2084	96415	4	44	MPAP	2.27 ~~3.76~~	RD				02	005	04	04	16		2.27 ~~3.70~~	999	308	59 RECOND REGULATOR			05-9
209	56130	4	CX							0F	036	05	09	12				309	59 WAITING PARTS			
2104	96415	4	44	MPAG	2.12 ~~.40~~	RD				02	001	09	09	15		2.12 ~~.40~~	999	310	59 RECOND HSG/METER SET			05-9
2114	96415	4	44	MPAE	1.3 [illegible]	D				00	007	09	10	10		1.34 [illegible]	999	311	59 ~~PRE-WELD~~ ASSEMBLE NOZZLES			05-9
2124	96415	4	44	MECL	8.36 [illegible]	RD				0?	005	10	10	15		8.36 [illegible]	999	312	59 PRE-TEST/ROUTE FOR WELD			05-9
213	56130	4	CX							00	011	10	12	10				313	59 WAITING WELD-ASSEMBLY			
2144	96415	4	44	MECM	5.83	D				02	007	12	13	11		5.83	999	314	59 PRESS/FINAL TEST			05-9
2154	96415	4	X?	MPA3	.60	D				0?	007	13	13	13		.60	999	315	59 S/W SELL			05-9
2162	96415	4	65	T021														316	T/R PPC 0064			
2171	96415	4	65	T030														317	C/W LES NI36C11-77			
216	42323		70															318	QV FINAL ACCEPT			
219			02															319	QTY OF 10			
220	52202		70															320	CARD REQD FOR LOGSELL			
221	56130		CF							02	007	13	13	15				321	72			

MISCELLANEOUS INFORMATION GROUP

MDR LOCATION	SPECIAL INSTRUCTIONS
401	REF 401 RESCINDED PPC 77 PRT III METERING SET CHANGE

TECHNICAL DATA GROUP

MDR LOCATION	TECHNICAL DIRECTIVES	MDR LOCATION	TECHNICAL DIRECTIVES	MDR LOCATION	TECHNICAL DIRECTIVES	MDR LOCATION	TECHNICAL DIRECTIVES
501	ER 0176A	502	PPC 0064	503	LES NI36C11-77		

Figure 4. MDR with changes indicated.

STANDARD DATA APPLICATION RECORD
NAVAIR FORM 5220/6 (7-68) S/N 0102-LF-610-2380

SHOP NO.	ORGANIZATION TITLE	TECHNICIAN	FILE REFERENCE / ACTIVITY	DATE
6315	NARF	Lindquist	N I	7-25-76

TECHNICAL REFERENCE:
OPERATION: Gage Dove tail.
PART NUMBER:
JOB DESCRIPTION: Ck. dovetail c̄ dial indicator J79 2nd Stg.
PART NAME: Blade Turb. 2nd Stg J79

NO.	DESCRIPTION	CODE	QUANTITY 1ST	QUANTITY ADD	GROSS	OCC	ALLOWED
A	Prep to check.				268	0100	268
1	Get pans of blades LH T.	ONH-LA-OC	2		38		
2	Additional walk	OBM-UO-01	4		36		
3	Arrange N.A.	OMH-LA-OA	6		30		
4	Get gage	OMH-LA-OB	1		12		
5	Open box	AGF-OU-LC	1		73		
6	Adjust dial – zero	BAC-KD-03	8		40		
7	Get empty tote pan	OMH-LA-OA	4		20		
8	Sit stand	BBM-SS-03	1		19		
B	Ck. dovetail.				60	9700	5820
1	Get blade position in gage	OOH-PO-OA	1		12		
2	Read dial	OIT-EV-OA	1		12		
3	Rem. blade & turn for opp. side	OOH-PO-OA	1		12		
4	Read dial	OIT-EV-OA	1		12		
5	Aside blade to totepan	OMH-LA-OB	1		12		
C	Blades aside				169	0200	338
1	Sit stand	BBM-SS-03	1		19.		
2	Get pan of blades.	OMH LA OC	2		38		
3	Move to conveyor	OBM-UO-01	4		36.		
4	Paper Ticket	TBJ IJ PA	1		76		

Standard figured on 85% of blades. [illegible]

TOTAL	1426
PERSONAL 5 % FATIGUE 7 % SUPPLEMENTAL 4 %	
ALLOWANCE HOURS	1024
EPS(HR) D 000.74 or	7454

☆ U.S. Government Printing Office: 1970—[illegible] PAGE ____ OF ____

44.72 min.

Figure 5. Standard data application record.

JN 25K0409 SHOP ORDER - UADPS FOR INAS 0A 01S MS 100 C24 59 323

C245932	PRI 4 HSG-BRG-SL	NI	2SA00	100500001300	1
	8W J79-10	S706			1
	867C759P1		028-105AGD-6-1/2		433286

						MWC	OPERATION CODE	STD CD	OPERATION STANDARD	OPERATION DESCRIPTION	SUPERVISOR INSPECTOR
02	96411	Q	MX	018	018						
03	96427	Q	BP	019	019	4	MORK	D	.07	1XC	
04	97314	Q	BP	019	019	4	MORA	D	.05	51-8A	
05	96411	Q	70							62	
06	97331	F	BP	020	021	4	ZBJA	D	1.55	08-P81 2F-SEE NOTE 1	
07	97331	F	BP	022	022	4	ZANA	D	.22	01-P61 20	
08	97322	F	BP	022	022	4	YBFA	D	.08	01-P64 7F	
09	57140	Q	XF	023	023					63	

NOTE 1--MCR 360214-77

C245932	HSG-BRG-SL	25K0409-3-JRUC-C2459323	100500001300	1-1

Figure 6. Uniform automated data processing (UADP) card.

3. Production centers, which are located throughout the PPD shop areas and vary in size according to the shop they serve. A production center is usually supervised by a GS-9. However, a PC person supervising the production center in more than one shop is usually a GS-11. Each center is organized to move engine components and parts according to schedules and in response to priority changes.

The more experienced PC personnel, some of whom are journeymen artisans, are assigned to the centers, while the less experienced are assigned to transport materials between the centers. The latter, some of whom are referred to as expeditors, are usually GS-4s. The PC group's overall responsibility is to ensure that all rework is completed on a timely basis. In addition to the functions already described, PC personnel estimate overtime requirements, determine the interchangeability of parts, obtain shop equipment repair services, and screen and initial the final paperwork.

Being assigned to the PC group was once considered a promotion for shop artisans. However, during past reorganizations, PDs were changed so that nonmechanics are now being assigned to the PC group. This result has become somewhat of a controversial issue at the NARF. Some feel that a competent PC person must have a mechanic's background, especially when situations occur requiring detailed physical identification of materials.

Examination and Evaluation (E&E)

E&E personnel (1) review all the documents associated with the engine and its components (i.e., the engine section of the aircraft maintenance log book, the MDR and UADP cards, local engineering change directives, and other routine directives concerning the engine's rework) and (2) visually inspect the engine and its components to determine the degree of rework needed. They send the components that do not need rework to a holding area (kitting center) where all the parts for that particular engine eventually arrive, and the components that do need rework to the appropriate shop after deleting any unnecessary operations from the appropriate sets of UADP cards. Shop personnel then disassemble the components to make internal examinations and evaluations, and delete any unnecessary part rework processes from the UADP cards. E&E personnel are senior mechanics who are promoted from the various PPD shops.

Engineering

The PPD's Engineering group does engineering on an "as needed" basis. Its primary function is to provide engineering solutions to problems encountered during the rework process. Such solutions eventually result in a change to the manufacturer's maintenance manuals used in the shops, officially called a local engineering change (LEC). These LECs, which, in turn, result in changes to the relevant MDRs, can be issued when (1) an incorrect procedure is discovered, and the Engineering group either corrects it or establishes an alternative one, (2) the group finds that an alternate procedure suggested by an artisan is an improvement over the original procedure, or (3) some wording in a manual needs to be clarified. The Engineering group's job of "keeper of the manuals" is a continuous one. LECs can be made even after 10 years of reworking a particular engine. Although a pilot engine needs little reworking at first to return it to service condition, the amount of reworking needed increases as a function of the engine's age. Some rework processes may not be performed until years after the engine has been in service and through the NARF PPD many times.

Quality Assurance (QA)

The Quality Assurance (QA) group consists of two different subgroups, one for quality verification (QV) and the other, for quality engineering and analysis (QE&A).

1. Quality Verification (QV). This subgroup usually makes product quality checks at the end of rework jobs. Although some QV checks are occasionally made on a sampling basis while work is in progress, the in-process quality of work is primarily the responsibility of the artisan. The frequency of sampling is determined by the importance of the process; that is, whether it is classified as critical, important, and nonimportant (types 1, 2, and 3 respectively). Type 1 processes are listed on "quality check lists" (QCLs) given to the artisans. Thus, artisans always request a quality check for those jobs (i.e., 100% checking). Artisans are not aware of the actual sampling plans for types 2 and 3 processes, which are proportional to their relative importance.

Also, the QV subgroup uses an audit to check on (1) an artisan's work procedures, (2) the tools, equipment, and documentation used, and (3) the physical work environment. During an audit, the QV specialist addresses all items in a checklist related to procedures, tools, etc. If all the items on that list check out favorably, it is assumed that a quality product will result.

If a QV specialist observes an artisan following incorrect procedures, he completes a "slant-three" chit (see Figure 7) with the relevant information about the discrepancy, and provides a copy to the artisan, the PC group, and the foreman. When the discrepancy has been corrected, the QV person issues a "no defect" chit to the three parties involved.

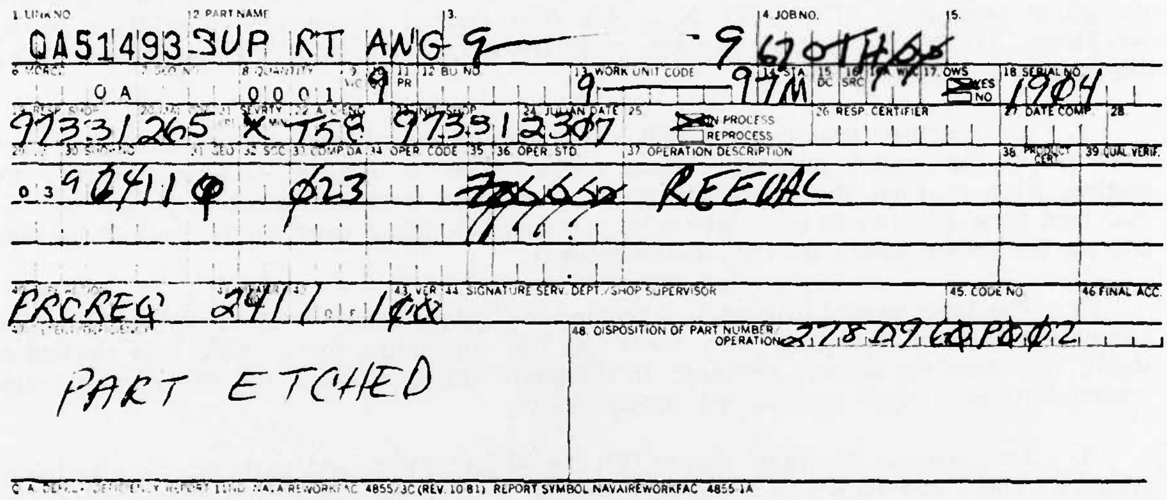

Figure 7. Slant-three quality report chit.

When situations affecting quality that are not covered in the manuals and documents arise, the QV person completes a "material review disposition record" and submits it to the Material Screening Board (MSB), which is chaired by a QA representative and includes representation from the P&E and PC groups. Issues not resolved by the MSB are forwarded to the Material Review Board, which is also chaired by a QA representative, and which also includes representatives from the E&E and Engineering group. The few issues that cannot be settled by these two boards are discussed at a meeting of the respective division directors.

2. Quality Engineering and Analysis (AE/A). This subgroup investigates reported engine and component failures from all sources. It is also responsible for seeing that the LECs and other directed procedural changes are actually incorporated into the manuals and the MDRs.

In addition to the discrepancy reports described under QV, discrepancies are reported from other sources. When a quality-related discrepancy is reported by the production workers themselves (one that occurred even though they followed prescribed rework procedures), the procedures are reviewed and, if necessary, revised. When a quality-related discrepancy is reported by an engine test cell, it is traced back to the rework processes and a determination is made as to what corrective actions are required. When a quality-related discrepancy is found in the fleet and reported to the NARF by a Navy message, the related rework operations may come to a halt until it is determined why the discrepancy occurred and what remedial action needs to be taken. All the analyses are done by the QE&A group.

Controlling Documents

Every organization has a set of controls in the form of directives, reports, and/or computer programs. The PPD shops use four control documents in relation to the workflow: UADP cards, labor reports, critical short charts, and hi-burner tables. These documents are described below:

1. As indicated previously, UADP cards accompany all components, units, and parts that are in the rework process. These cards (shown in Figure 6), which identify the engine, shop routing, the processes to be performed by the respective shops, and the standard time allotted to complete each process, tell the artisan what needs to be done and the PC person where the unit should go next.

2. The labor report (Figure 8), a computer printout that is issued daily for each shop and covers the previous day's work, identifies the work units, the artisans who worked on them, the time the artisan required to complete the processes, and the corresponding standard times allotted to complete the processes.

3. The critical shortage charts (Figure 9) list parts and units to be given high priority. These charts, which are issued weekly, list the parts and components needed to meet the next week's assembly schedule but that have not arrived in the assembly pool as scheduled.

4. The hi-burner report (Figure 10) lists the parts and components urgently needed by the Naval Air Logistics Supply System to support fleet operations.

Flow Process Charts

Industrial engineers often use flow process charts in tasks involving job design, process flow, work simplification, plant layout, etc. Figure 11 provides an example of a completed flow process chart. In this effort, a set of flow charts was constructed for each of the eight PPD shops selected for study to identify and describe representative processes employed in those shops. A set of charts represents a shop's entire operation; and an individual chart, a specific component of that operation. The charts were used (1) to estimate the relative lengths of the processes (i.e., number of steps), (2) to estimate the number of transactions per process, and (3) to determine how shop workloads were distributed.

SHOP LABOR REPORT RPT ID ZS1ST?C1 RPT SYM 4?1LW1?-1 RPT DATE [illegible]-26-81 PAGE 1

SHOP NUMBER 9EN1S SHIFT 1

EMP NO	EMPLOYEE NAME	TRN DAY	STRT TIME	STOP TIME	JOB-ORD NUMBER	LINK NUMBER	LN NO	TR CD	COMP IDENT NUMBER	SFC NO	EXP HRS	EXP TO DATE	STD CD	STD HRS	SCH DAY	WTC	ERROR LEGEND
[illegible]9014	A DUCKWORTH	16	0650	1500	2VFC401	V256177	13	1	410100000000	W514	6.00	8.00	D	11.[illegible]	118	500	
											8.00						
[illegible]	[illegible] HINES	6	0650	0756	27WT115	V244575	25	1	110100000000	W269	.99	2.77	D	1.73	123	62[illegible]	
		16	0759	0760	22W0215	V244514	03	1	111100001100	W269	.11	.11	C	.2[illegible]	118	62[illegible]	
		6	0760	0955	2DFC103	V3.7611	06	1	110100000000	X311	1.95	1.95	D	.70	120	500	
		06	1005	1006	664CA[illegible]		00	1			.[illegible]					500	
		16	1008	1116	22WT373	V023110	07	1	110100005500	5839			2		067	620	LK/LN ON WIP,NOT MINI
		6	1119	1118	27WT374	VC-6899	07	1	110100005300	5841			2		91	62[illegible]	LK/LN ON WIP,NOT MINI
		6	1116	1116	2DFC103	V3.7611	06	1	110100020000	X311	.67	2.55	D	.70	120	620	
		6	1118	1167	22WT114	V276642	03	1	110100001100	W268	.49	.65	C		116	600	
		6	1167	141[illegible]	3224352	V059119	13	1	0000A3520000	0001	2.43	2.43	D	1.[illegible]	089	600	
		06	1410	14[illegible]	2UFC131	V326859	[illegible]2	1	313100000000	5A10	.72	.77	D	[illegible].59	124	620	
		6	1480	15[illegible]	2UFT131	V326858	[illegible]4	1	313100000000	5A10	.18	.19	D	.41	125	62[illegible]	
											7.[illegible]						
5317[illegible]	J CAMERON	16	0650	15[illegible]	664WA[illegible]		00	1			8.00					500	
											8.[illegible]						
52372	R A FREYER	6	0650	15[illegible]	37DHA57	V172479	18	1	2000HA670000	0001	8.00	17.3[illegible]	D	2[illegible].17	114	5[illegible]	
											6.[illegible]						
57[illegible]14	R S CROWLEY	16	0650	[illegible]815	372HMW2	V249056	12	1	0000HMW20000	0001	1.65	14.59	D	19.4[illegible]	127	500	
		16	0815	0922	664CA[illegible]		00	1			1.[illegible]7					500	
		6	0922	15[illegible]	372HMW2	V249256	12	1	0000HMW20000	0001	5.29	19.85	D	19.4[illegible]	127	500	
											8.[illegible]						
54553	W G NOURSE	16	0650	1500	62WT114	V278985	11	1	410100000000	W268	8.00	8.55	C	.70	118	500	
											8.[illegible]						
59365	R W C[illegible]OOKS	16	0650	15[illegible]	372HMW2	V172296	12	1	2000HMW20000	0F01	8.00	8.00	D	19.4[illegible]	116	500	
											8.[illegible]						
5[illegible]97[illegible]	[illegible] WEASE	6	0650	0777	372HAS2	V172786	11	1	2000HAS20000	0002	1.27	17.27	D	17.34	116	6[illegible]	
		16	0777	1192	3F2TU53	VC29892	13	1	0007Y090000	0001	1.63	1.63	C	3.5[illegible]	10[illegible]	620	
		6	1192	1192	3F2TU53	VC29892	13	1	000C7Y097000	0001	1.62	3.65	C		100	620	

Figure 8. Labor report.

TO: 51610 & 51630	FROM: 51620 FINISHED PARTS POOL - CRITICAL SHORTAGES													
THRU 9/1	WOOD	SCHEDULE: LX X X				T53		STA: 80				8/25		
	SEQUENCE	X 319	LX 877	LX 878	LX 879	LX 62A	LX 880	LX 63A	X 320					
	TYPE	-5	-10	8F	8F	-5	-10	-5	-5					
	DATE	8/17	8/20	8/21	8/24	8/26	8/26	8/31	9/1					
	COLUMN	A	B	C	D	E	F	G	H	I	J	K	L	M
1	COMP. ROTOR 30010000		✓	✓	✓	✓	✓	✓	✓					
2	C/C ROTOR 10230000					✓	✓	✓	✓					
3	P/T ROTOR 40052000					✓	✓	✓	✓					
4	NOZ # 1 SEG: 10060000					✓	✓		1ea. ✓					
5	NOZ # 2 10190000						✓							
6	NOZ # 3 10150000				✓		✓	✓	✓					
7	CASE # 1 10180000								✓					
8	CASE # 2 10140000								✓					
9	COMB. LINER 30031030					✓	✓		✓					
10	COMB. CASES 30031110													
11	STATOR CASES. 30021010				✓	✓	✓		✓					
12	COMP. R/FRAME 30031010								✓					
13	EXHAUST CASE 40051010	✓		✓					✓					
14	SEAL BRG. REAR 30031050					✓	✓							
15	SEAL AIR 30031180					✓	✓							
16	RING SEAL 40051030		✓		✓		✓		✓					
17	HSG. BRG. FWD. 40051040			✓					✓					
18	FRM FR CASE 2001 1010		F ✓					✓	✓					
19														
20														
21														
22														
23														
24														

3

Figure 9. Critical shortage chart.

FUNCTION: "HI-BURNER" SUBJ: 4-81 PRODUCTION SCHED. EFFECTIVE DATE: 1 JULY 1981 PAGE 2 OF 3
TO: DISTRIBUTION FROM: 571-61 SIGNED: H.F. BAXTER DATE: 1 JUNE 81

SHOP	FGC.	NOMENCLATURE	SHOP T.A.T.	TOT. REQ.	CUMULATIVE SHOP PRODUCTION SCHEDULE 7/4	7/11	7/18	7/25	8/1	8/8	8/15	8/22	8/29	9/5	9/12	9/19	9/26
6411	L66A	J79 SCAV. PUMP	18	15	1	3	4	5	6	8	9	10	11	12	14	15	15
"	QWRA	T58 FLOW DVDR.	12	32	3	5	8	11	13	16	19	21	24	27	29	32	32
"	RNJA	T58 LUBE PUMP	14	40	4	7	10	14	17	20	24	27	30	33	37	40	40
"	XMHA	T58 P/T ACC. DRV.	14	15	1	3	4	5	6	8	9	10	11	13	14	15	15
"	XPSA	T58 FLOW DVDR.	12	10	1	2	3	3	4	5	6	7	7	8	9	10	10
6414	SENA	J79 E.G.T. SWITCH	14	30	3	5	8	10	13	15	18	20	23	25	28	30	30
"	STVA	J79 NOZZ. CONT.	20	30	3	5	8	10	13	15	18	20	23	25	28	30	30
"	B9BA	J79 NOZZ. CONT.	13	7	1	1	2	2	3	3	4	4	5	6	6	7	7
"	DK65	T58 IGN. UNIT.	20	18	2	3	5	6	8	9	10	12	13	15	16	18	18
"	EPPA	H46 ROTOR DMPR.	18	50	4	8	13	17	21	25	29	33	37	41	45	50	50
6415	K431	J79 FUEL NOZZLE	15	45	4	8	11	15	19	23	26	30	34	37	41	45	45
6416	ALYA	J79 FUEL CONTROL	37	22	2	4	6	8	9	11	13	15	17	18	20	22	22
"	E9BA	J79 FUEL CONTROL	28	2	0	0	0	0	0	1	1	1	2	2	2	2	2
"	E9SA	T58 FUEL PUMP	17	50	4	8	12	17	21	25	29	33	37	41	45	50	50
"	JM3A	T58 PURIFIER	13	35	3	6	9	12	15	18	20	23	26	29	32	35	35
"	NO9A	T64 FUEL CONT.	52	20	2	4	5	7	9	10	12	14	15	17	19	20	20
"	QAYA	T58 FUEL CONT.	33	40	3	7	10	13	16	20	23	26	30	33	36	40	40
"	VE8A	T58 FUEL CONT.	31	15	1	3	4	5	6	8	9	10	11	13	14	15	15
6421	EUCO	J79 TURB. NOZZLE	18	250	21	43	63	83	104	125	146	167	188	208	229	250	250

SCHEDULE OR STATUS SHEET (UNIVERSAL) NAVAIREWORKFAC-4851/5 (REV 5-81)

Figure 10. Hi-burner report.

FLOW PROCESS CHART		NUMBER	PAGE NO.	NO. OF PAGES
			1	2
PROCESS: Gae Generator (T-64)				
MAN OR MATERIAL				
CHART BEGINS: Loeding eection	CHART ENDS: Shop PC pickup area			
CHARTED BY: T. P. Enderwick	DATE: 7/ /81			
ORGANIZATION: 96315 Shop				

SUMMARY: ACTIONS	PRESENT NO.	PRESENT TIME	PROPOSED NO.	PROPOSED TIME	DIFFERENCE NO.	DIFFERENCE TIME
○ OPERATIONS						
◇ TRANSPORTATIONS						
□ INSPECTIONS						
D DELAYS						
▽ STORAGES						
DISTANCE TRAVELLED (Feet)						

	DETAILS OF PRESENT / PROPOSED METHOD	OPERATION / TRANSPORTATION / INSPECTION / DELAY / STORAGE	DISTANCE IN FEET	QUANTITY	TIME	ANALYSIS	NOTES	ANALYSIS
1	Generator loaded in ehop	●◆□D▽	70				PC	
2	Record in log book	●◆□D▽	20				1st mechanic	
3	Unit traneported to work bench	○◆□D▽	36				" "	
4	Examination of paper work for work required	○◇■D▽	-				" "	
5	Dieeeeemble generator	●◇□D▽	-				" "	
6	0-3 parts (examine & inspect)	○◇■D▽	-				" "	
7	Designate work to be done on paper and cards	●◇□D▽	-				" "	
8	Tag and route parte	●◇□D▽	-				" "	
9	Traneact unit	●◆□D▽	180					
10	Remaining nute, bolts and paper work in basket	●◇□D▽	-				1st mechanic	
11	Baeket in mechanic'e storage	○◆□D▼	28				" "	
12	Parte all or partly arrive from PC pool	○◇□D▼	-				PC	
13	Traneport from etorage to bench	○◆□D▽	28				1st mechanic	
14	Check paper and parte for work done	○◇■D▽	-				" "	
15	Partial aesembly when only limited parts are in	●◇□D▽	-				" "	
16	Complete aeeembly when all parts available	●◇□D▽	-				" "	
17	Traneact unit	●◆□D▽	140					
18	Prepare for balance ehop mount bal. bearinge	●◇□D▽	-				1st mechanic	
19	Traneport to balance ehop area	○◆□D▽	52				" "	
20	Belance generator	●◇□D▽	-				2nd mechanic	
21	Transact unit	○◆□D▽	160					

Figure 11. Flow process chart.

Table 1 shows the workload percentage required by representative units for these shops. This table shows that (1) the PPD reworks and overhauls a fairly representative cross section of the engines and their components, (2) the steps within the processes include the entire range of rework activities (e.g., disassembling, inspecting, reworking parts, assembling, balancing, and testing), and (3) the identified processes cover between 65 to 100 percent of each shop's workload. Thus, it appears that all the shops are suitable for participating in the PEP. All processes listed in the flow charts each require one artisan to complete and transact. The one exception to this is in shop 96314, where the disassembly process of the basic engine requires two mechanics. After that step, however, the two mechanics individually disassemble the engine subassemblies (components) and transact the completed work.

Table 1

Workload Percentage Required by Representive Units by Selected PPD Shops

Representative Units for Rework/Overhaul	Reference Engine	Percentage of Workload	Number of Steps	Number of Transactions
T-64 Small Engine Rework and Tests Shop (96314)				
1. Gas generator	T-64	5	26	4
2. Torque sensor rework	T-64	5	22	5
3. Power rotor turbine	T-64	8	18	5
4. Engine drive shaft	T-64	8	21	3
5. 413 compressor	T-64	8	52	2
6. Balance processes	T-64	8	8	1
7. Engine subassemble; disassemble	T-64	37	7-19[a] (Avg 13)	2-6[a] (Avg 4)
8. Engine subassemble; assemble	T-64	7	5	1
9. Engine assemble	T-64	7	5	1
10. Engine test	T-64	7	6	1
[a]Depends on number of subassemblies to be disassembled				
Gearboxes/Electrical Shop (96411)				
1. Bungee (rod-flap RFL) recondition	---	15	22	4
2. Repair ignition exciter box	T-64	15	26	4
3. Electrical harness	---	10	10	2
4. Gearbox; transfer gearbox	J-79	60	24	2
Oil/Fuel Pumps, Filters, Actuators, and Accessories Shop (96412)				
1. Lub. pump	T-58	20	25	5
2. Hydraulic pump	---	10	15	3
3. Fuel pump	J-79	25	26	5
4. After burner fuel control	---	20	24	4
5. Other	---	25	--	-
Fuel Controls Shop (96413)				
1. Main fuel control (disassemble, exam., and route)	J-79	10	19	2
2. Main fuel control (disassemble, exam., and route)	T-58	10	20	2
3. Fuel control (assembly and test)	Both	75	17	3
4. Other	---	5	--	--
Fuel Accessories and Valves Shop (96414)				
1. Fuel nozzles	T-64	30	26	2
2. Pilot valves	---	50	20	5
3. Flow dividers	---	15	20	5
4. Others	---	5	--	-
Nozzle and Weld Shop (96421)				
1. Combustion liner reconditioning	T-58	5	11	4
2. First-stage nozzle reconditioning	J-79	35	24	9
3. Second-stage nozzle reconditioning	J-79	35	25	7
4. Other rework processes	---	25	--	-
Metal and Weld Shop (96422)				
1. Transition duct	J-79	40	12	2
2. Combustion liners	J-79	30	6	2
3. Combustion liner (disassembly and repair)	J-79	30	10	3
Machine Shop (Small) (96424)				
1. Transfer gearbox	J-79	30	16	4
2. Engine front frame	T-64	35	13	1
3. Other rework processes	---	35	--	-

Mini-survey Results

Results of the mini survey, which are presented in Table 2, shows that, on the average, foremen felt the six criteria rated were being met over 80 percent of the time.

Table 2

Degree to Which PPD Shops Meet Criteria

Shops	Criteria: Work Measured Objectively (%)	Work Could be Measured Objectively (%)	Valid Standards in Place (%)	Performance Tied to Individual (%)	Work Re-curring in Nature (%)	Work Pace Tied to Individual (%)	Average (%)
96314	90	83	69	94	100	96	88.7
96411	60	80	80	25	90	70	67.5
96412	75	80	75	50	85	75	73.3
96413	100	75	75	100	100	100	91.7
96414	50	75	75	90	95	95	80.0
96421	90	90	75	100	100	90	90.8
96422	90	90	95	85	85	80	87.5
96424	90	90	85	85	90	80	86.7
Average	80.6	82.9	78.6	78.6	93.1	85.8	83.3

Recommended Experimental and Control Shops

The shops recommended for inclusion in the experimental and control groups are listed in Table 3. As shown, the two groups are remarkably similar in terms of the four criteria used for selection. The first set of shops was selected as the experimental group over the second set because it contains shops from a wide cross-section of the PPD.

Table 3

Recommended Experimental and Control Groups

Shop Number	Criteria: Percentage of criteria met	Percentage of workload covered by PFCs	Number of people in the shop	Ratio of steps per transactions
Experimental Group				
96314	89	100	20	6.5
96411	68	100	14	6.9
96421	90	75	35	3.0
96424	87	75	16	5.8
Average	83.5	85.0	21.3	5.6
Control Group				
96412	73	75	13	5.3
96413	91	75	32	8.0
96414	80	95	18	5.5
96422	88	100	29	4.0
Average	83.0	86.3	23.0	5.7

Impediments to Productivity.

Some of the impediments listed below can be eliminated or reduced by PPD management, and others cannot. Most of them can affect one or more of the PPD shops at any given time; a few affect a shop's productivity constantly. The P&E group can provide more information on impediments 1-3; and the QA group, on impediment 4.

1. Withdrawal of rework funds. When NARF customers withdraw rework funds to support emergency operations elsewhere, a stop order is issued and reworking is halted on the set of engines affected, wherever this work may be in the PPD.

2. Engine arrival delays. Although schedules on the number and types of engines to be handled are developed annually and updated quarterly, operational circumstances (e.g., an emergency deployment) can delay engine arrivals, resulting in a temporary low level of available work.

3. Accelerated schedules. Because of insufficient backlog, overtime generated through the successful shops due to accelerated fleet replacement needs is followed by a period of very low workloads.

4. Engine failure messages. When the fleet experiences repeated engine failures that appear to have similar causes, NARF is advised to discontinue rework on the particular type and series of engines until a cause determination is made.

5. Rework done by other divisions. When engine parts are routed for reworking to other NARF divisions (e.g., to the Metal Manufacturing Processing Division for replating work) that have their own schedules, inordinate delays may occur, impeding the PPD work flow.

6. Production control personnel shortages. While the Production Control (PC) staff is generally viewed as productive, these are not enough people to move parts and material between and within shops and perform other PC functions. Consequently, the practice is to have shop personnel provide support (i.e., in moving materials and making up hardware kits (nuts, bolts, & washers). This practice is well known within the PPD but it is not reflected in the labor reports.

7. Delays in parts availability. Although assembly and rework processes require an orderly arrival of parts, many delays occur because (a) parts are not available or are misrouted, and (b) shops may accumulate parts to be reworked, to save set-up time, without realizing that those parts are needed by rework or assembly workers in other shops.

8. Work specialization. Work specialization, especially prevalent among some of the older artisans, proves disruptive when specialists are ill or on leave. To discourage this practice and prevent future occurrences, supervisors are rotating workers among the various operations within the shop.

9. Personnel procedures. Supervisors and managers, at all levels, must spend a disproportionate amount of time meeting the collective requirements of personnel directives, instructions, and union agreements.

10. Required absence of the foreman. Shop productivity has suffered because shop foremen are required to spend increasing amounts of time away from the shop attending

to personnel programs and other matters, leaving his alternate in charge. The alternate cannot be expected to do as effective a job as the foreman.

11. Foreman rotation. Shop foremen need technical, administrative, and managerial skills if they are to maintain and/or improve productivity. The NARF practice of rotating foremen among shops is unproductive, in that it often results in a first-line supervisor with less shop knowledge than the workers and, to some extent, places the foreman at the mercy of his workers. A foreman should be rotated only for "cause."

12. Equipment breakdowns. While breakdowns are to be expected with any equipment, older equipment breakdowns are more frequent. The equipment in some of the shops is long overdue for replacement.

13. Equipment out of alignment. Unaligned equipment that is not detected leads to unnecessarily long processing time (e.g., balancing) as well as to poor quality. Alignment problems can be due to (a) aging equipments, which do not hold their alignments as well as newer equipments, (b) the possibility that the equipment was not properly aligned in the first place, and (c) "drifting" resulting from normal use.

14. Time standards on work cards. All foremen interviewed felt that time standards should be removed from work cards because workers completing a rework process before the time specified often view the remaining time as "free time." Since the time required to rework a part depends upon its condition or state of disrepair, the time standard represents more of an average than a set time.

CONCLUSION

The results of this study indicate that the PPD is a sound candidate for the development of a PEP. The PPD organization will work with the research team to eliminate any impediments or control their affects, thereby creating the proper environment to develop the program.

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